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"PHARMACOLOGICAL INVESTIGATION OF THE ANTI-INFLAMMATORY & ANTI- CANCER EFFECT OF SOME HERBAL MEDICINAL PLANTS"

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INDEX

SR.NO.	Content	Page No.
01	ABSTRACT OF PROPOSED WORK PLAN	**01**
02	INTRODUCTION	**02-05**
03	REVIEW OF LITERATURE AND DEVELOPMENT IN THE SUBJECT	**06-08**
04	OBJECTIVES OF RESEARCH	**09**
05	METHODOLOGY TO BE ADOPTED	**10**
06	IMPORTANCE OF STUDY	**11**
07	PROPOSED WORK PLAN	**12**
08	REFERENCES	**13-17**

01. ABSTRACT OF PROPOSED WORK PLAN

The present synopsis is for pharmacological evaluation of a selected medicinal plant part(s) extract for their possible anti-inflammatory and anti-cancer effect. After proper literature survey the selected plant part(s) will be collected at its flouring season. The selected plant part(s) will be authenticated, cleaned, dried and powdered for extraction with different solvents (Non-polar to Polar). Preliminary phytochemical investigation will be carried out;extract will be subjected for fractionation. The fractionated plant part(s) extract will then evaluated for acute toxicity study for the determination of safe dose (as per OECD guidelines) and screened for its preliminary anti-inflammatory effect in animal models. The fractionated plant part(s) extract will then evaluated for anti-inflammatory activities in experimentally Carrageenan induced paw oedema model and Cotton pellet-induced granuloma model in animals. The fractionated plant part(s) extract will then evaluated for anti-cancer activities in *in-vitro* model. The obtained data will then statistically interpret, results will be analyzedand the research findings will be disseminated by publications for the health care providers.

02. INTRODUCTION

Inflammation is a process which begins following a injury to tissue and ends with complete healing". Unregulated inflammation can lead to persistent tissue damage and leads to a variety of inflammatory disorders. Acute inflammation is a rapid and self-limiting process: chemical mediators are induced in a tightly regulated sequence, immune cells move in and out of the affected area, destroying infectious agents, repairing damaged tissue, hence, initiating a specific and long-term response to the pathogen.(1) However, acute inflammation does not always resolve. Rudolf Virchow, in 1863 observed leukocytes within tumors and hypothesized that malignant neoplasm occurred at the sites of chronic inflammation, which provided the first indication of a possible link between inflammation and cancer.(2) Any failure in the control of the components of the immune response can lead to chronic inflammation and the generation of a microenvironment that might favor the initiation and progression of cancer. The longer the inflammation persists the higher the probability of genomic instability and mutations that lead to cancer.(3)

Inflammation and cancer are connected by two pathways: extrinsic pathways from conditions that cause non-resolving smouldering inflammatory responses and intrinsic pathways driven by oncogenes or tumor suppressor genes that activate the expression of inflammation-related programmes.(4) Normal cells possess intrinsic mechanisms to prevent unregulated proliferation or the accumulation of DNA mutations. These include the intervention of tumor suppressor genes like p53 that direct DNA repair, apoptosis, cell cycle arrest and senescence. Failure of these mechanisms also contributes to cancer development.(5)

Virchow indicated that cancers tended to occur at sites of chronic inflammation.(6) Lately, it turned out that acute inflammation contributed to the regression of cancer.(7) However, accumulated epidemiologic studies support that chronic inflammatory diseases are frequently associated with increased risk of cancers.(8) The relationship between inflammation and cancer first led to the determination whether the reactive oxygen and nitrogen species generated by inflammatory cells, such as leukocytes recruited to the inflammatory foci to kill infectious agents, may cause mutagenic assaults and result in tumor initiation.(9) Now, it has been realized that the development of cancers from inflammation might be a process driven by inflammatory cells as well as a variety of mediators, including cytokines, chemokines, and enzymes, which altogether establish an inflammatory micro environment.(9) Although this host response may suppress tumors, it may also facilitate cancer development via multiple signaling

pathways.[10]Prostaglandin E2[11], transforming growth factor-h[12], and reactive oxygen and nitrogen intermediates [13] are among those molecules with a dual role in both promoting and suppressing inflammation.

Macrophages and other inflammatory cells generate a great amount of growth factors, cytokines, and reactive oxygen and nitrogen species that may cause DNA damage.[8] If the macrophages are activated persistently, they may lead to continuous tissue damage.[14] Chronic inflammation may contribute to carcinogenesis, the risk of esophageal, pancreatic and gallbladder cancer may be increased by inflammatory diseases, such as esophagitis, Barrett's metaplasia, and chronic pancreatitis.[15] Possible associations were also found in Marjolin's ulcer and skin carcinoma, asbestos and mesothelioma, silica, cigarette smoke, and bronchial cancer[14], chronic asthma and lung cancer[16], sarcoidosis and lung, skin, and liver cancer[17], ulcerative lichen planus and verrucous carcinoma.[18]

COX-2, a major target of non-steroidal anti-inflammatory drugs, NSAIDs, is strongly upregulated in some cancers. Population based studies show that chronic uses of NSAIDs such as aspirin reduce overall risk of colorectal cancer by 40%–50%.[19] Aspirin, and more selective COX-2 inhibitors such as celecoxib, delays the development of premalignant adenomas in patients who have been cured of sporadic colorectal carcinoma, or patients genetically predisposed to the development of adenomas and colorectal cancer.

However, some data suggest that aspirin use may increase risk of pancreatic cancer and non-Hodgkin's lymphoma.[20] At this moment in time, there does not seem a strong case for general use of aspirin or other NSAIDs for the sole reason of reducing risk of sporadic cancer, when potential adverse effects are taken into account. This dissertation work gives the link between cancer and inflammation and discusses the implications of these links for cancer prevention and treatment. The response of the body to a cancer is not a unique mechanism but has many parallels with inflammation and wound healing.[21]

Therefore; we have selected plant part(s) will be authenticated, cleaned, dried and powdered for extraction with different solvents (Non-polar to Polar). Preliminary phytochemical investigation will be carried out;extract will be subjected for fractionation.

Medicinal plants are the "backbone" of traditional medicine, which means more than 3.3 billion people in the less developed countries utilize medicinal plants on a regular basis. [22]Medicinal plants are of great value in the field of medicine and cure of diseases.Practical

experience and several modern research studies have shown that therapy using plants is better than using synthetic chemicals by being safer besides having synergistic effect of their active ingredients and presence of certain minerals and salts. There is still large number of medicinal plants in which all active constituents have not yet been investigated even though their medicinal effect is established by folklore and traditional system of medicine. The traditional system of medicine has utilized herbal formulations for treating various human ailments. The side effects of drugs of chemical origin have shifted focus of researchers towards natural therapeutics for curing health related problems in living beings.

Although medicinal plant based herbal therapy is in existence from centuries but scientific validation is still a difficult challenge for developing herbal medicines. Multiple studies have shown that compounds and extracts derived from plants can cure or delay health related decline and extend lifespan and health span across a variety of species. Major hindrance in amalgamation of herbal medicine in modern medical practices is lack of scientific and clinical data proving their efficacy and safety. There is a need for conducting clinical research inherbal medicine, developing simple bioassays for biological standardization, pharmacological and toxicological evaluation and developing various animal models for toxicity and safetyevaluation. It is also important to establish the active components from herbal extract.

There are enough evidences which indicate involvement of inflammatory process and their mediators in cancer induction. These mediators if timely interfered can stop the progression of carcinogenic changes. The numerous anti-inflammatory agents are being used in cancer treatment with same approach and are showing promising outcome in cancer treatment. In coming time many more anti-inflammatory agents will be promoted and implicated for their promising outcome in therapeutics for cancer management.

Hence, in present investigation we planned to pharmacological evaluation of a selected medicinal plant part(s) extract for their possible anti-inflammatory and anti-cancer activities to strengthen the above approach.

INFLAMMATION IN CANCER

Cytokines are small glycoproteins that have pleiotropic effects on healthy cells, stimulating growth, differentiation, and activation. They are part of both the innate and adaptive immune systems. Depending on the microenvironment, cytokines can have pro-inflammatory, anti-inflammatory, or immune suppressive effects. Many human cellscan produce cytokines, but immune cells are primarily responsible. Cytokines' primary function is to serve as a short-distance paracrine and autocrine communication pathway between cells and tissues [23, 24].

Pro-inflammatory cytokines are important at various stages of carcinogenesis, and inflammation has been shown to play a significant role in cancer development. Cellular differentiation,proliferation, apoptosis and growth suppression evasion, enhanced vascularity,invasion, metastasis, altered cellular metabolism, and immunological evasion are all examples of poorly regulated processes in the human body. Cancer is caused by an imbalance of pro- and anti-inflammatory mechanisms, which leads to chronic immune system activation and inflammation[25–28].Cytokines such as tumor necrosis factor-alpha (TNF-), interleukin-6 (IL-6), and IL-10 have been linked to cancer spread[25, 28-33].

03. REVIEW OF LITERATURE:

Hassan *et al* (2024) has reported that the study investigated five anti-inflammatory medicinal plants: *Schwenkiaamericana*, *Asparagus africanus*, *Dichrostachyscinerea*, *Ficusiteophylla*, and *Indigoferapulchra*, highlighting their saponin-rich extracts significant effects on reducing inflammation in carrageenan-induced rat paw-oedema[34].

Matos *et al* (2024) in this review showed that identified 126 anti-inflammatory medicinal plants traditionally used in Brazil, with 40 species included in the study. Phytochemical analyses revealed over 225 compounds, primarily phenolic, supporting their potential pharmacological properties for treating various inflammatory disorders[35].

Lebeloane *et al* (2024) in this study investigated seven anti-inflammatory medicinal plants: *Dichrostachyscinerea, Ehretiarigida, Salix babylonica, Vachelliaerioloba, V. gerrardii, V. sieberiana,* and *V. tortilis*, highlighting their potential as livestock feed additives to reduce inflammation and promote health[36].

Chethan *et al* (2024) in this review showed that various medicinal plants known for their anti-inflammatory properties, highlighting their potential as alternatives to non-steroidal anti-inflammatory drugs (NSAIDs) due to fewer side effects and their ability to interfere with the inflammatory response effectively [37].

Pongkitwitoon *et al* (2024) in this study identified several anti-inflammatory medicinal plants from the Lamiales order, including *Barleriaprionitis, B. lupulina, Rhinacanthusnasutus, Orthosiphonaristatus,* and *Nicotebabetonica,* which exhibit high levels of verbascoside and isoverbascoside, contributing to their anti-inflammatory properties [38].

Suchada *et al* (2023) in this study demonstrated that the Clear belongs plus extract (CBL-P) from five medicinal plants exhibited significant anti-inflammatory activity by inhibiting nitric oxide production and potent anticancer activity against human cancer cell lines, suggesting potential therapeutic benefits in cancer treatment [39].

Fabio *et al* (2023) in this study revealed that *Mouririelliptica* and *Alchorneaglandulosa* exhibit anti-inflammatory and cytotoxic activities. A. glandulosa inhibits NO and TNF-α

production, while M. elliptica produces NO. These plants show potential as sources of new anti-inflammatory compounds and antitumor agents against Ehrlich carcinoma [(40)].

Belma *et al* (2023) in this study highlighed that triterpene fractions from Lamiaceae family plants exhibit significant anti-inflammatory and anti-proliferative activities. Notably, *Rosmarini folium* demonstrated the strongest effects, supporting its traditional medicinal use for anti-inflammatory and anticancer purposes[(41)].

Adryan *et al* (2022) in this review contained that phytochemicals such as apigenin, sanguinarine, and rosmarinic acid, which contribute to their therapeutic effects against melanoma skin cancer and inflammation. Medicinal plants like Chamomile, Sanguinariacanadensis, and Rosemary exhibit both anti-inflammatory and anticancer activities [(42)].

Nitin *et al* (2023) in this review discussed that anti-inflammatory medicinal plants include *Lantana camera linn.,Azadirachtaindica, Murrayakoenigii, Curcuma longa, Zingiberofficinale,* and *Hibiscus rosasinensis*, which possess various phytochemical substances contributing to their anti-inflammatory properties [(43)].

Peter *et al* (2023) in this review discussed that various anti-inflammatory medicinal plants, highlighting compounds such as alkaloids, glycosides, terpenoids, steroids, and polyphenolic compounds. These herbs are gaining popularity due to their effectiveness and fewer side effects compared to synthetic drugs for treating inflammatory conditions[(44)].

Ayushi *et al* (2023) in this study identified four medicinal plants with anti-inflammatory properties: *Saracaasoca, Ficusbenghalensis, Chenopodium album,* and *Nyctanthes arbor-tristis*. Notably, *Nyctanthes arbor-tristis* shows significant potential for treating rheumatoid arthritis, warranting further research[*(45).*]

Bui *et al* (2023) in this paper summarized numerous studies on various medicinal plants and their bioactive compounds that exhibit anti-inflammatory properties, suggesting their potential as alternative treatments for inflammatory diseases to reduce tissue damage and enhance patient comfort[(46).]

Sugashini *et al* (2023) in this study evaluated that the anti-inflammatory activity of medicinal plants from the Cucurbitaceae family, specifically Momordicacharantia, Citrulluslanatus, Cocciniagrandis, and Lagenariasiceraria, using methanol and petroleum ether leaf extracts through a protein denaturation assay[47].

Sarjalia Jyoti (2023) in this review highlighted various medicinal plants with anti-inflammatory activities, emphasizing their complex bioactive compounds that target multiple pathways in inflammation. These plants have shown efficacy in treating both acute and chronic inflammatory conditions, supporting traditional herbal medicine's role in modern therapy[48].

Mohamed *et al* (2023) in this review identified 58 medicinal plant species with anti-inflammatory properties, primarily from the Asteraceae family. Notable active compounds include myricetin, quercetin, hesperetin, rutin, luteolin, and various acids such as chlorogenic and ferulic acid, among others[49].

Sergio *et al* (2023) in this research study identified that medicinal plants from the *Lamiales, Gentianales,* and *Asterales* orders used in European folk medicine for treating inflammatory disorders. Notably, species from the *Scrophularia*and *Plantago genera* significantly reduce P2X7 receptor activation, indicating their anti-inflammatory potential[50].

Shebina *et al* (2023) in this review identified that anti-inflammatory medicinal plants include *Moringaoleifera, Glycyrrhizaglabra, Zingiberofficinale*, and *Mimosa pudica*. These herbs contain phytoconstituents that exhibit significant anti-inflammatory properties, making them safer and more effective alternatives to synthetic anti-inflammatory medications [51].

Jingchen *et al* (2024) in this study discussed that medicinal and edible homologous plant (MEHPs) rich in phenolic acids, which exhibit significant anti-inflammatory activity. Notable examples include caffeic acid, ferulic acid, and chlorogenic acid, highlighting their potential in treating inflammatory diseases[52].

04. OBJECTIVES OF RESEARCH

Literature survey reveals that several plants have always been proven as a better source of drugs when it comes to treatment of inflammation, cancer and its complication.
Hence, it was thought worth to undertake present study to screen anti-inflammatory, anti-cancer activities of the medicinal plants.

The broader objectives set for the pre-clinical studies are as follows-

- To evaluate the selected plant part(s) extract for effective control of inflammation, cancer and its long term complications as a therapeutic/supplementary medicine.
- To extract the plant part (s) using proper solvent(s).
- To use the current scientific literature(s) to identify potential target compounds.
- To evaluate the pharmacological activities of plant part (s) extract.
- To investigate the effects of plant part (s) extract on cancer cell line.
- To investigate the anti-inflammatory effects of plant part (s) extract.
- To rationalize the ethanomedical information by statistically proving its effects preclinically.
- To disseminate of the research findings by publications for the health care providers and lay public.

It is expected that this study could provide a scientific basis for the use of a plant part(s) extract in herbal medicine to ameliorate the complications of inflammation and cancer.
The rationale for cancer study is to improve the prevention, detection, and treatment of cancer, and to help patients live longer and better lives.To detect pre-cancer or early-stage cancer in asymptomatic individuals so that timely diagnosis and early treatment can be offered,

05. METHODOLOGY TO BE ADOPTED

1. Collection and authentication of selected plant part(s)

The plant material will be collected, authenticated, cleaned, dried and powdered for further process.

2. Preliminary Phytochemical Investigation

A. Extraction

The plant part(s) will be subjected for extraction with different polarity solvents (Non-polar to Polar)

B. Preliminary phytochemical investigation

Preliminary phytochemical investigation of plant part(s) extract will have carried out by qualitative chemical test and chromatographic technique.

3. Acute toxicity study

For the determination of safe dose, the plant part(s) extract will be subjected for the acute toxicity according to OECD guidelines.

4. Evaluations of anti-inflammatory activity of plant part(s) extract

The plant part(s) extract will be studied for anti-inflammatory activity using a carrageenan-induced paw edema model and a Cotton pellet-induced granuloma model in animals.

5. Evaluations of anti-cancer activity of plant part(s) extract

The plant part(s) extract will be subjected for study of anti-cancer activity using various cancer cell lines.

06. IMPORTANCE OF STUDY

- The study will be supportive to treat the various complications due to inflammation and cancer in patients.
- Medicinal plant based medicine is expected to have fewer side effects as compared to the modern drugs.
- The present study will be helpful to minimize the cost of the treatment of diseases due to inflammation and cancer.
- This study uses the plants as medicines which have been not fully explored and that are why it will be very important to investigate the anti-inflammatory and anti-cancer potential of these plants.
- This study functional to isolate the potent component from medicinal plants which have maximum anti-inflammatory and anti-cancer effect as compared to the synthetic drugs.

7. PROPOSED WORK PLAN

Sr. No.	ResearchWork	TentativeTime In Month(S)
1.	Literature survey	03
2.	Selection,Collection and authentication of plant material(s)	02
3.	Extraction of plant part(s)	02
4.	Preliminary phytochemical evaluation of plant part(s)extract	02
5.	Pharmacological evaluations	
	Acute Toxicity Study for the determination of safe dose (as per OECD guidelines)	01
	Anti-inflammatory activity 1) Rat paw oedema 2) Cotton pellet Granuloma pouch 3) Protein denaturation	06
	Anti-cancer activity	06
6.	Statistical interpretation and result analysis	02
7.	Research publication	06
8.	Completion of research work and thesis writing	03

08. REFERENCES

1. Balkwill F, Charles KA, Mantovani A. Smoldering and polarized inflammation in the initiation and promotion of malignant disease. Cancer cell. 2005 Mar 1;7(3):211-7.
2. Mantovani A, Allavena P, Sica A, Balkwill F. Cancer-related inflammation. nature. 2008 Jul 24;454(7203):436-44.
3. Balkwill F, Mantovani A. Inflammation and cancer: back to Virchow?. The lancet. 2001 Feb 17;357(9255):539-45.
4. Balkwill FR, Mantovani A. Cancer-related inflammation: common themes and therapeutic opportunities. InSeminars in cancer biology 2012 Feb 1 (Vol. 22, No. 1, pp. 33-40). Academic Press.
5. Morrison WB. Inflammation and cancer: a comparative view. Journal of veterinary internal medicine. 2012 Jan;26(1):18-31.
6. Balkwill F, Mantovani A. Inflammation and cancer: back to Virchow?. The lancet. 2001 Feb 17;357(9255):539-45
7. Philip M, Rowley DA, Schreiber H. Inflammation as a tumor promoter in cancer induction. InSeminars in cancer biology 2004 Dec 1 (Vol. 14, No. 6, pp. 433-439). Academic Press.
8. Coussens LM, Werb Z. Inflammation and cancer. Nature. 2002 Dec 19;420(6917):860-7.
9. Okada F. Inflammation and free radicals in tumor development and progression. Redox report. 2002 Dec 1;7(6):357-68.
10. Yang CR, Hsieh SL, Ho FM, Lin WW. Decoy receptor 3 increases monocyte adhesion to endothelial cells via NF-κB-dependent up-regulation of intercellular adhesion molecule-1, VCAM-1, and IL-8 expression. The journal of immunology. 2005 Feb 1;174(3):1647-56.
11. Levy BD, Clish CB, Schmidt B, Gronert K, Serhan CN. Lipid mediator class switching during acute inflammation: signals in resolution. Nature immunology. 2001 Jul;2(7):612-9.
12. Hodge-Dufour J, Marino MW, Horton MR, Jungbluth A, Burdick MD, Strieter RM, Noble PW, Hunter CA, Puré E. Inhibition of interferon γ induced interleukin 12 production: a potential mechanism for the anti-inflammatory activities of tumor necrosis factor. Proceedings of the National Academy of Sciences. 1998 Nov 10;95(23):13806-11.
13. Nathan C. Points of control in inflammation. Nature. 2002 Dec 19;420(6917):846-52.
14. Macarthur M, Hold GL, El-Omar EM. Inflammation and Cancer II. Role of chronic inflammation and cytokine gene polymorphisms in the pathogenesis of gastrointestinal

malignancy. American Journal of Physiology-Gastrointestinal and Liver Physiology. 2004 Apr;286(4):G515-20.

15. Whitcomb DC. Inflammation and Cancer V. Chronic pancreatitis and pancreatic cancer. American Journal of Physiology-Gastrointestinal and Liver Physiology. 2004 Aug;287(2):G315-9.
16. Alavanja MC, Brownson RC, Benichou J, Swanson C, Boice JD. Attributable risk of lung cancer in lifetime nonsmokers and long-term ex-smokers (Missouri, United States). Cancer Causes & Control. 1995 May;6:209-16.
17. Askling J, Grunewald J, Eklund A, Hillerdal G, Ekbom A. Increased risk for cancer following sarcoidosis. American journal of respiratory and critical care medicine. 1999 Nov 1;160(5):1668-72.
18. Carlson JA, Ambros R, Malfetano J, Ross J, Grabowski R, Lamb P, Figge H, MihmJr MC. Vulvar lichen sclerosus and squamous cell carcinoma: a cohort, case control, and investigational study with historical perspective; implications for chronic inflammation and sclerosis in the development of neoplasia. Human pathology. 1998 Sep 1;29(9):932-48.
19. Koehne CH, Dubois RN. COX-2 inhibition and colorectal cancer. InSeminars in oncology 2004 Apr 1 (Vol. 31, pp. 12-21). WB Saunders.
20. Schernhammer ES, Kang JH, Chan AT, Michaud DS, Skinner HG, Giovannucci E, Colditz GA, Fuchs CS. A prospective study of aspirin use and the risk of pancreatic cancer in women. Journal of the National Cancer Institute. 2004 Jan 7;96(1):22-8.
21. E. Shacter, S. A.Weitzman,Chronicinflammation and cancer.Oncology 16 2002217–232.
22. Mahmood ZA, Sualeh M, Mahmood SB, Karim MA. Herbal treatment for cardiovascular disease the evidence based therapy. Pakistan Journal of Pharmaceutical Sciences. 2010 Jan 1;23(1).
23. N. Kolodkin A, Sharma RP, Colangelo AM, Ignatenko A, Martorana F, Jennen D, Briedé JJ, Brady N, Barberis M, Mondeel TD, Papa M. ROS networks: designs, aging, Parkinson's disease and precision therapies. NPJ systems biology and applications. 2020 Oct 26;6(1):34.
24. Quinlan CL, Perevoshchikova IV, Hey-Mogensen M, Orr AL, Brand MD. Sites of reactive oxygen species generation by mitochondria oxidizing different substrates. Redox biology. 2013 Jan 1;1(1):304-12.
25. Seruga B, Zhang H, Bernstein LJ, Tannock IF. Cytokines and their relationship to the symptoms and outcome of cancer. Nature Reviews Cancer. 2008 Nov;8(11):887-99.

26. Conlon KC, Miljkovic MD, Waldmann TA. Cytokines in the treatment of cancer. Journal of Interferon & Cytokine Research. 2019 Jan 1;39(1):6-21.
27. Morris RM, Mortimer TO, O'Neill KL. Cytokines: can cancer get the message?. Cancers. 2022 Apr 27;14(9):2178.
28. Browning L, Patel MR, Horvath EB, Tawara K, Jorcyk CL. IL-6 and ovarian cancer: inflammatory cytokines in promotion of metastasis. Cancer management and research. 2018 Dec 5:6685-93.
29. Bromberg J, Wang TC. Inflammation and cancer: IL-6 and STAT3 complete the link. Cancer cell. 2009 Feb 3;15(2):79-80.
30. Bharti R, Dey G, Mandal M. Cancer development, chemoresistance, epithelial to mesenchymal transition and stem cells: A snapshot of IL-6 mediated involvement. Cancer letters. 2016 May 28;375(1):51-61.
31. Jones SA, Jenkins BJ. Recent insights into targeting the IL-6 cytokine family in inflammatory diseases and cancer. Nature reviews immunology. 2018 Dec;18(12):773-89.
32. Nguyen DP, Li J, Tewari AK. Inflammation and prostate cancer: the role of interleukin 6 (IL-6). BJU international. 2014 Jun;113(6):986-92.
33. Taher MY, Davies DM, Maher J. The role of the interleukin (IL)-6/IL-6 receptor axis in cancer. Biochemical Society Transactions. 2018 Dec 17;46(6):1449-62.
34. Hassan H. S., Sule M. I., Musa A. M., Musa K. Y., Abubakar M. S., Hassan A. S. Investigating the Anti-Inflammatory Activity of Saponin-Rich Extracts from Selected Medicinal Plants. IBS-V10 [Internet]. 2024 Aug. 26 [cited 2024 Dec. 14];:47-58.
35. R., C., de, Matos., Ana, F, A, Bitencourt., Alexsandro, D, M, de, Oliveira., Vanessa, R, Prado., Renes, R., Machado., Marina, Scopel. Evidence for the efficacy of anti-inflammatory plants used in Brazilian traditional medicine with ethnopharmacological relevance. Journal of Ethnopharmacology, (2024).118137-118137.
36. M.M., Lebeloane.,Ibukun, M., Famuyide., K.G., Kgosana., E.E., Elgorashi., K.K., Ndivhuwo., Vinesh, Maharaj., L.J., McGaw. Anti-inflammatory activity of seven plant species with potential use as livestock feed additives. South African Journal of Botany, (2024).; 167:322-332.
37. M, L, Chethan., T, Shekshavali., D., Ganesh., Krupasagar, P, N.. A Review on Analgesic and Anti-inflammatory Activities of Traditional Medicinal Plants. Research Journal of Pharmacology and Pharmacodynamics, (2024).247-250.
38. B., Pongkitwitoon.,Waraporn, Putalun., Kanokporn, Triwitayakorn., Tharita, Kitisripanya., Tripetch, Kanchanapoom., Panitch, Boonsnongcheep. Anti-inflammatory

activity of verbascoside- and isoverbascoside-rich Lamiales medicinal plants. Heliyon, (2024).

39. Suchada, Jongrungraungchok.,Fameera, Madaka., Thaniya, Wunnakup., Teeratad, Sudsai., Chanamon, Pongphaew., Thanapat, Songsak., Nalinee, Pradubyat. In vitro antioxidant, anti-inflammatory, and anticancer activities of mixture Thai medicinal plants. BMC complementary medicine and therapies, (2023).;23(1).
40. Fábio, A, Malara., Djamile, Cordeiro, de, Matos., Livia, Carolina, de, Abreu, Ribeiro., T, O, R, Falcoski., Teresinha, de, Jesus, Aguiar, dos, Santos, Andrade., Vanessa, N.C., Santos., Nerilson, M., Lima., Iracilda, Zeppone, Carlos. Medicinal Plants from Brazilian Cerrado Biome: Potential sources of new anti-inflammatory compounds and antitumor agents on Ehrlich carcinoma..Anais Da Academia Brasileira De Ciencias, (2021).;93.
41. Belma, Pehlivanović.,Haris, Niksic., Irma, Gusic., Emina, Koric., M., Dedic., Belma, Tuna-Repovac., Fahir, Becić., Kemal, Durić. Anti-proliferative and anti-inflammatory activity of triterpene extracts from plant species belonging to Lamiaceae family. Latin American and Caribbean Bulletin of Medicinal and Aromatic Plants, (2023).;22(6):864-878.
42. Adryan, Fristiohady., Rathapon, Asasutjarit., La, Ode, Muhammad, Julian, Purnama., Sewan, Theeramunkong., Wirhamsah, Al-Ramadan., Lidya, Agriningsih, Haruna., Nur, Syifa, Rahmatika., Syarul, Nataqain, Baharum., Idin, Sahidin. Phytochemical Profile and Anticancer Activity from Medicinal Plants Against Melanoma Skin Cancer: A Review. Indonesian journal of science and technology, (2022).;7(3):405-470.
43. Mr., Nitin, N., Mali.,Dr.Swapnil, R., Nazarkar., Miss., Payal, B., Phadtare., Miss., Ankita, L., Pimpale. Review on Anti-inflammatory and Anticoagulant Activity of Medicinal Plants. International Journal of Scientific Research in Science and Technology, (2023).
44. Peter, De, Roux, Sumer.,Bimal, Debbarma., Kmensiful, Binan., Waibiangki, Lyngdoh., Loushambam, Samananda, Singh. Therapeutic Insights into Anti-Inflammatory Activities Derived from Medicinal Plants. Uttar Pradesh Journal of Zoology, (2023).
45. Ayushi, Sharma.,Anjana, Goel. Phytochemical Studies, Anti-Oxidant and Anti-Inflammatory Properties of Four Medicinal Plants. Journal of Ecophysiology and Occupational Health, (2023).
46. Bui T. Tung, Tran V. Linh, Trinh P. Thao, Nguyen D. Thuan.Anti-inflammatory Agents from Medicinal Plants. (2023).219-250.

47. Sugashini, Settu.,Sathiavelu, Arunachalam. Evaluation of Anti-inflammatory activity of selected medicinal plants of Cucurbitaceae family. Research journal of pharmacy and technology, (2023).1598-1600.
48. SarjaliaJyotiA review on medicinal plants with anti-inflammatory activities. International journal of pharmaceutical sciences and medicine, (2023).;8(4):66-77.
49. Mohamed, Bnouham.,Saliha, Bouknana., Rhizlan, Abdnim., Ali, Berraaouan. Medicinal plants and bioactive compounds with potential anti-inflammatory and antidiabetic activities: a review. Letters in Drug Design & Discovery, (2023).;20.
50. Sergio, Ortiz., Katarina, Šavikin., F., Massicot., Elodie, Olivier., Mélody, Dutot., Patrice, Rat., Brigitte, Deguin., Dejan, Gođevac., Nebojša, Menković., Jelena, Živković., Gordana, Zdunić., Sabrina, Boutefnouchet. P2X7-receptor pathway involvement in the anti-inflammatory activity of medicinal plants.. Chemistry & Biodiversity, (2023). e202300427.
51. Shebina, P., Rasheed.,Nuzrath, Kp., S., R., M., K. Miracles of Herbal Phytomedicines as Potent Anti-Inflammatory Agents. International journal of pharmaceutical sciences review and research, (2023).;79(1).
52. Jingchen, Xie., Shaoxiang, Xiong., Yamei, Li., Bo-Hou, Xia., Minjie, Li., Zhimin, Zhang., Zhe, Shi., Qiuxian, Peng., Chun, Li., Liang, Lin., Duan-Fang, Liao. Phenolic acids from medicinal and edible homologous plants: a potential anti-inflammatory agent for inflammatory diseases. Frontiers in Immunology, (2024).;15.

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